

Amendments to the Drawings:

FIG. 2F' is added to the drawings. This figure is attached hereto at the end of this paper.

REMARKS/ARGUMENTS

The applicants thank the Examiner for his Office Action mailed January 19, 2005. **Claims 1, 6, 7, and 17** are amended herein. Accordingly, **Claims 1-20** are currently pending in the application.

A new figure, **FIG. 2F'**, has been added to more explicitly illustrate certain subject matter that is well described in the Specification at, for example, page 11: line 9 to page 12: line 14 as well as elsewhere in the Specification. No new matter has been introduced.

Additionally, a paragraph has been added to describe the added figure. This paragraph is also well supported, for example, in the Specification at page 11: line 9 to page 12: line 22. Accordingly, reconsideration and allowance are hereby requested.

Objections to the Drawings:

The Office Action has objected to certain claims that include a limitation of "tilted calcium ion implants" as being unsupported by the drawings. The applicants believe such claim language is well supported by FIG. 2F in view of the Specification at, for example, page 11: line 9 to page 12: line 14 as well as elsewhere in the specification. For example in FIG. 2F the depicted implantation angle is about zero degrees (i.e., a tilted implant of about zero degrees). However, in an effort to further clarify this point, the applicants have added a new drawing Fig. 2F' which is believed to lay this matter to rest. No new matter is added. The applicants believe that this rephrasing of old subject matter overcomes the objections raised in the action.

Amendments to the Specification:

The applicants have added a paragraph which is essentially a rephrasing of existing subject matter contained, for example on page 12 of the Specification. Such rephrasing helps to clarify added FIG. 2F'. Due to the nature of such rephrasing, it is submitted that this added paragraph contains no new matter.

Rejections Under 35 U.S.C. § 112, 2nd paragraph:

Claims 6 & 7 have been rejected under 35 U. S. C. § 112, 2nd paragraph, as being indefinite. Consequently, Claims 6 & 7 have been amended to more correctly depend from Claim 2 which includes the antecedent limitation "tilted implants". It is respectfully submitted

that this amendment places the rejected claims in condition for allowance. Therefore, the applicants respectfully request that rejections of Claims 6 and 7 be withdrawn.

Rejections Under 35 U.S.C. § 102

Claims 1, 2, 4, 7, 8, 16-18, and 20 have been rejected under 35 U. S. C. § 102(e) as being anticipated by *Lopatin et al.* (USPN 6,703,307). It is important to note that *Lopatin* refers specifically to implanting a seed layer to create an improved seed layer/barrier layer interface. This point is made throughout the cited reference. For example, *Lopatin* uses a copper alloy seed layer 630 deposited over an existing barrier layer 620 (a non-implanted barrier layer) to form a seed implanted layer (e.g., 630; See, *Lopatin* 5:3-18 etc.). The *Lopatin* teaches several variations on this theme of forming a barrier layer, forming a seed layer, and then implanting the seed layer to enhance the electromigration resistance of copper layers. Alternatively, in some implementations *Lopatin* teaches that an existing barrier layer can be implanted by certain non-calcium implant materials to form a barrier layer with increased adhesion to an underlying dielectric layer.

These teachings miss the point of the present invention. Importantly, the cited art does not teach the implantation of the dielectric layer making up the trench sidewalls. Also, the present invention is a simplification of the laborious process of *Lopatin*. The present invention does not require the deposition of a barrier layer as does the cited art. This steps around the adhesion problems so rampant in deposited barrier layers such as that taught by *Lopatin*. Additionally, *Lopatin* focuses on the implantation of seed layer (and possibly the barrier layer in on embodiment). This is distinctly different from the implantation of the untreated trench claimed in the present invention. Embodiments of the present invention can create barrier layers by implanting materials into the dielectric layer (i.e., not into a existing barrier layer or seed layer).

The amendments to the claims readily illustrate these distinctions. For example, in Claim 1, the process includes "forming a trench" and "implanting Ca ions into the sidewalls of the trench" and "forming a seed layer over implanted sidewalls in the trench". Importantly, there is no implantation into an existing barrier (as required in the cited art) or implantation into a seed layer (also required in the cited art). More importantly, the implantation is achieved prior to the formation of a seed layer (or a barrier layer) as required by the cited art. Absent these limitations Claim 1 teaches a completely different invention. The concept of forming a dielectric layer and then implanting it to form a barrier layer is new. As is the subsequent formation of a

seed layer over the implantation layer. Thus, implanting a trench and then forming a seed layer formed thereon is new and not suggested by the cited art. Accordingly, the cited art does not teach all of the claim limitations.

This point is similarly made in Claim 17 wherein the IC includes "a first calcium implant region comprising a concentration of Ca atoms incorporated into the sidewalls of the channel under the seed layer using ion implantation". This is also not taught by any of the cited art. Absent any such teaching, the cited art fails to anticipate the claimed invention.

The cited art fails to anticipate the claimed inventions for several reasons, including the fact that the cited art fails to teach implanting the trench sidewalls to form a barrier layer and subsequently forming a seed layer over that implantation created barrier layer. Nor does the cited art teach implanting the trench sidewalls with calcium. In the cited art, calcium is only implanted into an existing barrier layer. Here, in the claimed invention, the implanted materials (e.g., calcium) are directly implanted into the trench prior to the formation of the barrier layer. Therefore, the applicants submit that the amendments to the claims have overcome the pending grounds of rejection. Accordingly, the applicants request that the Examiner withdraw the pending ground of rejection and allow the rejected claims.

Rejections Under 35 U.S.C. § 103

Claims 3, 5, 6, 9-11, 14, and 15 have been rejected under 35 U. S. C. § 103(a) as being unpatentable over *Lopatin*, in view of, variously, *Hook et al.* (USPN 6,0983,794) and *Besser et al.* (USPN 6,703,308) and also in view of MPEP 2144.05 II.

The applicants respectfully point out, for at least the reasons set forth above, that none of the cited art teach or suggest the limitations of "forming a seed layer over implanted sidewalls in the trench" (e.g., Claim 1 and all claims depending therefrom) or "a first calcium implant region comprising a concentration of Ca atoms incorporated into the sidewalls of the channel under the seed layer using ion implantation" (e.g., Claim 17 and all claims depending therefrom). *Lopatin* does not teach these limitations, nor do any of the supplementary references do anything to correct this deficiency. Absent any such teaching or suggestion the cited art fails to teach all of the claimed limitations. Therefore, the cited art has failed to establish a prima facie case of obviousness as the rejected claims. Accordingly, it is respectfully requested that this grounds of rejection be withdrawn as to Claims 3, 5, 6, 9-11, 14, and 15 allowed to issue.

Allowable Claims

Claims 12, 13, and 19 were deemed allowable if amended to incorporate the base claim and the intervening limitations. Because the applicants believe that the amendments to the base claims are sufficient to obtain allowance of all pending claims 12, 13, and 19 have not yet been amended. However, the applicants are willing, should it become necessary at some future time, to amend these claims.


Conclusion:

In view of the foregoing amendments and remarks, it is respectfully submitted that the claimed invention as presently presented is patentable over the art of record and that this case is now in condition for allowance.

Should the Examiner, for any reason, wish to contact the undersigned, he is cordially invited to do so at his convenience. Moreover, if the Examiner has any continuing concerns regarding this case, he is invited to contact the undersigned at (650) 961-8300.

Respectfully submitted,

BEYER WEAVER & THOMAS, LLP



Francis T. Kalinski II
Registration No. 44,177

P.O. Box 70250
Oakland, CA 94612-0250
Telephone: (650) 961-8300